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भाग 1 ताम्बे की अनावृत तारें (गोल)

Indian Standard

CONDUCTORS FOR ELECTRONICS AND TELECOMMUNICATION APPLICATIONS — SPECIFICATION

PART 1 BARE COPPER WIRE (ROUND)

ICS 29.060.10

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BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

November 1997

Price Group 3

Wires, Cables, Waveguides and Accessories Sectional Committee, LTD 18

FOREWORD

This Indian Standard (Part 1) was adopted by the Bureau of Indian Standards, after the draft finalized by the Wires, Cables, Waveguides and Accessories Sectional Committee had been approved by the Electronics and Telecommunication Division Council.

This standard covers the requirements and test methods for annealed high conductivity copper conductors for electronics and telecommunication applications.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

CONDUCTORS FOR ELECTRONICS AND TELECOMMUNICATION APPLICATIONS — SPECIFICATION

PART 1 BARE COPPER WIRE (ROUND)

1 SCOPE

This standard (Part 1) specifies requirements and tests for annealed high conductivity copper conductors for electronics, telecommunication, data and other signalling purposes.

NOTE — This standard does not apply to processed material, for example, conductors removed from insulated wires/cables.

2 REFERENCES

The following Indian Standards contain provisions which through reference in this text, constitute provision of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision and parties to agreement based on this standard are encourged to investigate the possibility of applying the most recent editions of the standards indicated below:

IS No.	*Title*
1885 (Part 32) : 1993	Electrotechnical vocabulary : Part 32 Electric cables (*first revision*)
191 : 1980	Copper (*third revision*)
9941 : 1981	Guide to calculation of resistance of plain and tinned copper conductors of low frequency cables and wires

3 TERMINOLOGY

For the purpose of this standard, the definitions given in IS 1885 (Part 32) shall apply.

4 GENERAL REQUIREMENTS

4.1 Material

The base material shall meet the requirements of IS 191.

NOTE — Acceptance of material shall be decided by conformance to resisitivity, annealing, and surface finish requirements of this standard.

4.2 Dimensions and Resistance

The dimensions and resistance of single strand conductors shall be as given in Table 1 and that of multistrand conductor shall be as given in Table 2.

4.3 Form of Conductor

The conductor shall be circular, solid or stranded, as required by the relevant specification.

The conductor shall be clean, smooth and its surface free from slime, cracks, pits, raised or sharp edges or other harmful defects.

4.4 Joints in Conductor

Joints in solid conductors larger than 0.2 mm diameter shall be made by butt welding, or silver brazing or cold weld. The fluxes used, if any, shall be non-corrosive. In case of stranded conductors, joints in individual conductors only are permissible but no joint shall be there within 300 mm of any other joint within the same layer.

5 PHYSICAL CONSTANTS (FOR INFORMATION)

5.1 Volume Resistivity at 20°C

This shall be equal to 0.017 241 ohm.mm^2/m. This is equal to conductivity of 100 percent IACS (International Annealed Copper Standard).

5.2 Density at 20°C

This shall be 8.89 g/cm^3.

5.3 Constant Mass Temperature Coefficient of Resistance

This shall be 0.003 93/°C.

5.4 Coefficient of Linear Expansion (Over the Temperature Range 0 to 150°C)

This shall be 17×10^{-6}/°C.

6 TESTS

6.1 Annealing

The sample shall be taken from the bobbin at least 1m away from the ends. The circular bare copper wire shall conform to the elongation requirements given in Table 1. The requirements for tensile strength are not applicable.

6.1.1 The elongation is determined by measurements made on a sample conductor held between the jaws of a tensile testing machine. The zero length is the distance between the jaws which shall be as near to 25 cm as possible. The final length is the distance between the jaws at rupture. The fracture shall not be closer than 2.5 cm from either jaw. The speed of separation of the jaws at no load shall not be greater than 125 mm/min. The load shall be applied gradually and uniformly.

6.1.2 The average elongation of minimum five specimens each taken from a different reel/coil shall be atleast 2.5 percent more than the appropriate minimum value specified in Table 1.

Failure of any one specimen from a reel/coil shall be cause for rejection of that reel/coil only.

6.2 Resistance

A kelvin double bridge or wheatstone bridge shall be used for this test. The measuring system shall have minimum accuracy of 0.2 percent for kelvin double bridge and 0.5 percent for wheatstone bridge. Wheatstone bridge may be used, if the measured value of resistance is greater than 1 ohm. Use of digital instruments having these accuracies is permissible.

The test specimens shall be of such a length that it has a minimum resistance of 1 500 μΩ. The resistance measurement shall be made preferably at 20°C.

In case the measurement is made at any other temperature, appropriate temperature correction factor from Table 3 shall be applied.

The value of resistance corrected to 20°C shall meet the values given in the relevant tables (Tables 1 and 2) of this standard.

6.3 Surface Finish

A visual test shall be taken on each conductor reel/coil. The samples shall be visually inspected for the attributes specified in **4.3** by unaided eye. (Normal spectacles accepted).

NOTE — A suggested method of checking surface finish is to rub the wire with polishing grade of emery paper (00 grade or finer) to remove any tarnish and observe for surface pits, crazes and cracks.

6.4 Diameter

The specimen used for resistance test shall be used for conductor diameter measurement. The diameter shall be measured at three places not less than 10 cm apart, and in two mutually perpendicular directions at each place. The measurements shall be made with a micro-meter accurate to 0.002 5 mm atleast. The average of six readings shall be taken as average diameter.

6.4.1 The measured values of the conductor diameter shall be within the maximum and minimum limits of Table 1.

6.4.2 The maximum diameter variation (between maximum and minimum diameter of sample taken at any cross section in two perpendicular directions) shall not exceed 0.01 mm for conductor diameters up to and including 0.5 mm and 2 percent of nominal diameter for conductor diameters greater than 0.5 mm.

7 SAMPLING

7.1 The sampling plan shall be as agreed between the manufacturer and the purchaser.

8 PACKING AND MARKING

8.1 The conductor shall be either wound on reels or drums, or supplied in coils and packed and labelled. The label shall contain the following information:

a) Manufacturer's name or trade-mark (if any),

b) Size of conductor, and

c) Length of conductor.

8.2 BIS Certification Marking

The conductor may also be marked with the Standard Mark.

8.2.1 The use of Standard Mark is governed by the provisions of *Bureau of Indian Standards Act*, 1986 and the Rules and Regulations made thereunder. Details of conditions under which a licence for the use of Standard Mark may be granted to manufacturers or producers may be obtained from the Bureau of Indian Standards.

Table 1 Single Strand Conductors

(*Clauses* 4.2, 6.1, 6.1.2, 6.2 *and* 6.4.1)

Diameter			Elongation	Resistance at 20°C	
Nom mm	*Min* mm	*Max* mm	*Min* percent	Nom ohm/km	*Max*[1] ohm/km
0.05	0.048	0.055	10	8 783	9 530
0.06	0.058	0.065	10	6 098	6 255
0.07	0.068	0.075	10	4 480	4 794
0.08	0.078	0.085	15	3 430	3 608
0.09	0.088	0.095	15	2 710	2 835
0.10	0.098	0.11	15	2 195	2 286
0.12	0.118	0.13	15	1 524	1 600
0.14	0.136	0.15	15	1 120	1 142
0.16	0.156	0.17	15	857.4	902.2
0.18	0.176	0.19	15	677.4	708.6
0.20	0.196	0.21	15	548.7	571.5
0.22	0.215	0.23	15	453.5	476.3
0.25	0.246	0.26	15	351.2	362.7
[2]0.32	0.31	0.33	20	214.4	220.8
0.36	0.35	0.37	20	169.4	174.5
[2]0.40	0.39	0.41	20	137.2	139.9
0.45	0.44	0.46	20	108.4	110.4
0.50	0.49	0.51	20	87.80	89.61
[2]0.505	0.495	0.515	20	86.07	88.65
0.60	0.59	0.61	25	60.97	62.81
[2]0.63	0.62	0.64	25	55.30	56.96
0.70	0.69	0.71	25	44.80	46.14
0.75	0.73	0.77	25	39.02	40.19
0.80	0.79	0.81	25	34.30	34.99
[2]0.90	0.89	0.91	25	27.10	27.65
1.00	0.99	1.05	25	21.95	22.61
1.20	1.18	1.25	25	15.24	15.70
1.30	1.28	1.32	25	12.99	13.38
1.40	1.38	1.45	25	11.20	11.43
1.60	1.58	1.65	25	8.574	8.747
1.80	1.78	1.85	25	6.775	6.914
2.00	1.98	2.05	25	5.488 0	5.600
2.24	2.20	2.30	25	4.375	4.506
2.50	2.48	2.55	25	3.512	3.584

[1] Higher allowance for stranding and cabling may be required for measurements on finished cables. In such cases, reference be made to IS 9941 or the user's standards.

[2] These sizes are specifically for underground telecommunication cables.

Table 2 Multistrand Conductors

(*Clauses* 4.2 *and* 6.2)

Nominal Cross-Sectional Area	No./Strand Dia	Resistance at 20°C	
		Nom	*Max*1)
mm²	mm	ohm/km	ohm/km
0.035	7/0.08	509.6	535.1
	19/0.05	480.8	504.8
0.060	7/0.10	327.1	342.4
	19/0.06	333.8	350.5
0.080	7/0.12	226.4	237.7
	19/0.08	187.7	197.1
0.125	7/0.16	127.4	133.8
	19/0.10	120.1	126.1
0.220	7/0.20	81.52	85.60
	19/0.12	83.42	87.59
0.340	7/0.25	52.10	54.79
	19/0.16	46.93	49.28
0.500	7/0.32	31.85	33.44
	16/0.20	35.66	37.44
	19/0.18	37.08	38.93
	28/0.16	31.84	33.43
0.560	7/0.32	31.85	33.44
	19/0.20	30.03	31.53
0.750	7/0.36	25.47	26.43
	19/0.20	24.83	26.07
	24/0.20	23.78	24.97
	42/0.14	27.73	29.12
1.000	7/0.45	16.11	16.92
	19/0.25	12.22	20.18
	32/0.20	17.83	18.72
1.500	7/0.50	13.05	13.70
	19/0.32	11.74	12.33
	30/0.25	12.17	12.78
2.500	7/0.70	6.656	6.989
	50/0.25	7.305	7.670

1) Higher allowance for stranding and cabling may be required for measurements on finished cables. In such cases, reference be made to IS 9941 or the user's standards.

Table 3 Temperature Correction Factors

(*Clause* 6.2)

Temperature °C (1)	Correction Factor (2)	Reciprocal of Factor (3)	Temperature (4)	Correction Factor (5)	Reciprocal of Factor (6)
5	1.062 6	0.941 1	20.5	0.998 0	1.002 0
5.5	1.060 4	0.943 0	21	0.996 1	1.003 9
6	1.058 2	0.945 0	21.5	0.994 1	1.005 9
6.5	1.056 0	0.946 9	22	0.992 2	1.007 9
7	1.053 8	0.948 9	22.5	0.990 3	1.009 8
7.5	1.051 7	0.950 9	23	0.988 3	1.011 8
8	1.049 5	0.952 8	23.5	0.986 4	1.013 8
8.5	1.047 3	0.954 8	24	0.984 5	1.015 7
9	1.045 2	0.956 8	24.5	0.982 6	1.017 7
9.5	1.043 0	0.958 7	25	0.980 7	1.019 7
10	1.040 9	0.960 7	25.5	0.978 8	1.021 6
10.5	1.038 8	0.962 7	26	0.977 0	1.023 6
11	1.036 7	0.964 6	26.5	0.975 1	1.025 5
11.5	1.034 6	0.966 6	27	0.973 2	1.027 5
12	1.032 5	0.968 6	27.5	0.971 4	1.029 5
12.5	1.030 4	0.970 5	28	0.969 5	1.031 4
13	1.028 3	0.972 5	28.5	0.967 7	1.033 4
13.5	1.026 2	0.974 5	29	0.965 8	1.035 4
14	1.024 1	0.976 4	29.5	0.964 0	1.037 3
14.5	1.022 1	0.978 4	30	0.962 2	1.039 3
15	1.020 0	0.980 4	35	0.944 3	1.058 9
15.5	1.018 0	0.982 3	40	0.927 1	1.078 6
16	1.016 0	0.984 3	45	0.910 5	1.098 2
16.5	1.013 9	0.986 2	50	0.894 5	1.117 9
17	1.011 9	0.988 2	55	0.879 1	1.137 5
17.5	1.009 9	0.990 2	60	0.864 2	1.157 2
18	1.007 9	0.992 1	65	0.849 7	1.176 8
18.5	1.005 9	0.994 1	70	0.835 3	1.196 5
19	1.003 9	0.996 1	75	0.822 3	1.216 1
19.5	1.002 0	0.998 0	80	0.809 2	1.235 8
20	1.000 0	1.000 0	85	0.796 5	1.225 5

NOTE — The temperature shall be read correct to nearest 1°C.

Bureau of Indian Standards

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